A11101 884766

Ref.

NBS Publi-cations

B. S. HANDBOOK SER. NO. 2 (2ND ED.)

QC
1
U51
copy 1
NBS
No.2

NATIONAL BUREAU OF STANDARDS LIBRARY

MAR 1 1923
Comm.
746743
Com.

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
S. W. STRATTON, DIRECTOR

NATIONAL SAFETY CODE FOR THE PROTECTION OF THE HEADS AND EYES OF INDUSTRIAL WORKERS

Office book not to be taken from the Library.

SECOND EDITION
DECEMBER 29, 1922

BUREAU OF STANDARDS
HANDBOOK SERIES

No. 2

U.S. BUREAU OF STANDARDS LIBRARY

PRICE, 10 CENTS
Sold only by the Superintendent of Documents
Government Printing Office

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

National Bureau of Standards
SEP 17 1947
61737

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
S. W. STRATTON, DIRECTOR

NATIONAL SAFETY CODE FOR THE PROTECTION OF THE HEADS AND EYES OF INDUSTRIAL WORKERS

SECOND EDITION
DECEMBER 29, 1922

BUREAU OF STANDARDS
HANDBOOK SERIES

No. 2

PRICE, 10 CENTS
Sold only by the Superintendent of Documents
Government Printing Office

WASHINGTON
GOVERNMENT PRINTING OFFICE
1923

CONTENTS.

	Page.
Introduction	5
Section 1. General requirements	9
10. Scope, application, and compliance	9
11. Classification of operations and processes	10
12. Definitions	11
13. Classification of protectors	12
14. Lenses for persons having defective vision	13
15. Replacement of lenses	13
16. General requirements for glass	13
Sec. 2. Protectors for chippers, riveters, calkers, etc., Group A	14
20. Styles permitted	14
21. Specifications and tests for lenses	14
22. Goggles of style No. 2	14
23. Goggles with flexibly connected lens containers, style No. 3	16
24. Test for frames	16
Sec. 3. Protectors for scaling, grinding, etc., Group B	17
30. Styles	17
31. Specifications for lenses	17
32. Goggle frames	17
Sec. 4. Protectors for exposure to dust and wind, etc., Group C	17
40. Styles	17
41. Specifications	17
Sec. 5. Protectors for babbitting, etc., Group D	18
50. Styles	18
51. Specifications for masks	18
52. Specifications for goggle frames	18
53. Specifications for lenses	18
Sec. 6. Protectors for handling corrosive chemicals, dipping, brush coating, etc., Group E	19
60. Styles	19
61. Specifications for goggles	19
62. Specifications for face masks	19
63. Specifications for hoods	20
64. Specifications for lenses	20

		Page.
Sec. 7.	Protectors for sandblasting, Group F	20
70.	Styles	20
71.	Specifications	21
Sec. 8.	Protectors for exposure to glare, Group G	21
80.	Styles	21
81.	Specifications	21
Sec. 9.	Protectors for oxy-acetylene welding, furnace work, etc., Group H	21
90.	Styles	21
91.	Goggles of style No. 1 or 2	22
92.	Eyecup goggles, style No. 3	22
93.	Face masks	22
94.	Helmets	23
95.	Specifications and tests for protective glass	23
Sec. 10.	Protectors for electric arc welding and cutting, Group I	23
100.	Styles	23
101.	Specifications for protectors	23
102.	Specifications and tests for windows	24
103.	Protection for other workers	24
Sec. 11.	Operating rules	25
110.	Sterilization	25
111.	Supply and fitting of goggles	25
112.	Replacement of defective protectors	26
113.	Inspection of protectors	26
114.	Cases	26
115.	Supply of protectors or repair parts	26
Sec. 12.	Tests for frames and glass	26
120.	Scope of tests	26
121.	Mechanical tests for frames of goggles	27
122.	Test for corrosion	28
123.	Mechanical tests for lenses	28
124.	Optical tests for lenses	29
Discussion of the rules		30
Index		63

INTRODUCTION.

The first edition of this code was completed in the fall of 1920 and issued early in 1921. It was prepared with the cooperation of an advisory committee of 19 men who had been selected because of their interest in and knowledge of the subject and as being typical representatives of the interests most closely concerned. The code was developed from a set of safety standards originally prepared in cooperation with safety engineers of the War and Navy Departments for use in Government establishments. These standards were drawn up rather hastily during the recent war, and after its termination were given more thorough study aided by experimental work at this bureau. Four preliminary drafts were issued in 1918 and 1919, and the questionable points were settled in 1920, although unanimous agreement was not obtained with reference to some of these.

The present edition of the code has been revised by a sectional committee organized under the auspices and in compliance with the rules of the American Engineering Standards Committee, which approved the previous edition of this code. The revised code has had the approval of this sectional committee and has been approved by the American Engineering Standards Committee as an American Standard. The sectional committee consists of the following persons:

L. R. Thompson, M. D., chairman, appointed by the United States Public Health Service.
M. G. Lloyd, secretary, appointed by the Bureau of Standards.
M. W. Alexander, appointed by National Industrial Conference Board.
C. R. Alling, appointed by Underwriters' Laboratories.
W. S. Andrews, appointed by American Bureau of Welding and American Welding Society.

H. J. Boggis, appointed by American Foundrymen's Association and National Founders' Association.

W. W. Coblentz, appointed by the Bureau of Standards.

P. J. Conlon, appointed by the International Association of Machinists.

J. N. Davis, appointed by the International Brotherhood of Boiler Makers and Iron Ship Builders and Helpers of America.

L. A. Ensminger, M. D. (E. S. Chapin, alternate), appointed by American Railway Association.

J. P. Frey, appointed by the International Molders Union of North America.

Walter Greenwood, appointed by the Association of Iron and Steel Electrical Engineers.

L. L. Hall, appointed by National Bureau of Casualty and Surety Underwriters.

Carl M. Hansen, appointed by the National Association of Manufacturers.

J. P. Meade, appointed by the Association of Governmental Labor Officials.

Henry N. Miller, appointed by National Association of Mutual Casualty Companies.

B. W. Nutt, appointed by Safety Appliance Manufacturers and Dealers Association.

C. E. Oakes.

F. D. Patterson, M. D., appointed by International Association of Industrial Accident Boards and Commissions.

H. D. Rouzer, Lieutenant Commander, United States Navy, appointed by the Bureau of Yards and Docks, Navy Department.

G. E. Sanford, appointed by American Society of Safety Engineers.

M. F. Tighe, appointed by Amalgamated Association of Iron, Steel, and Tin Workers.

E. D. Tillyer.

S. J. Williams, appointed by National Safety Council.

Frederick Willson, M. D., appointed by the Optical Manufacturers Association.

The arrangement of the code is such as to first present the general requirements, including a classification of the occupations which require eye protection. There then follows the detailed requirements for each group of occupations, operating rules, and finally the specifications for tests which must

be met to insure that protectors will adequately fulfill their purpose. The last section of the code giving these specifications need only be considered by manufacturers and those who must determine whether protectors are suitable for the intended purpose; that is to say, by those agencies who will determine the approval of goggles or other devices as complying with the requirements of this code or, in the absence of such approval, by the purchasers of goggles who wish to determine for themselves the adequacy of the protectors offered for sale.

Following the code is a discussion of the rules which is intended to assist the reader in understanding the reasons for the rules and in interpreting the rules, and to give suggestions for the best means of carrying them out. It is hoped that those having occasion to apply the rules will contribute from their experience to amplify this part of the publication in future editions.

The bureau will also be glad to receive criticisms of the code requirements, and suggestions for its improvement, especially such as are based upon actual experience in the application of the rules. It is expected to issue revised editions from time to time with such changes as wider experience may dictate.

December 27, 1922.

NATIONAL SAFETY CODE FOR THE PROTECTION OF THE HEADS AND EYES OF INDUSTRIAL WORKERS.

SECTION 1. GENERAL REQUIREMENTS.

10. Scope, Application, and Compliance.

(*a*) *Scope.*—The following rules apply to all industrial operations or processes which, by reason of the nature of the operation or process, present a sufficiently serious hazard to the head, face, neck, or eyes of a worker as to be liable to injure them.

Protectors are not required if the machine is furnished with guards which adequately protect the worker from the hazards classified in rule 11.

(*b*) *Application.*—Employers shall furnish protectors of a type suitable for the work to be performed, and the employee shall use such protectors when employed in processes or operations, or those of similar hazard, designated in rule 11 by the following letters: A, B, D, E, F, H, and I. Employers shall furnish protectors upon application of employees working in the processes or operations classified in Groups C and G, rule 11.

(*c*) *Compliance.*—The method to be pursued to assure that protectors will be used which meet the specifications and tests prescribed by these rules, shall be determined by the proper administrative authority.

The word "shall," where used, signifies that the requirement is mandatory and "should" advisory.

11. Classification of Operations and Processes.

The processes or operations in which it is necessary that the operator be given protection to the head or eyes, or both, are divided into nine groups, each of which requires a protector having distinctive features. The examples given for each group are illustrative only and are not intended to be complete lists of the operations or processes for which protection is necessary. These groups are as follows:

GROUP A.—Processes where protection from relatively large flying objects is required.

Examples of these processes are chipping, calking, and some riveting operations.

GROUP B.—Processes where protection from dust and small flying particles is required.

Examples are scaling and grinding of metals, stone dressing, and some woodworking operations.

GROUP C.—Operations where protection from dust and wind is required.

Examples are automobile driving, locomotive driving and firing, and electric spot and butt welding, where there is no exposure to radiant energy.

GROUP D.—Processes where protection from splashing metal is required.

Examples are babbitting, pouring of lead joints for cast-iron pipes, casting of hot metal if there is a possibility that water is present; and dipping in hot metal baths.

GROUP E.—Processes where protection from gases, fumes, and liquids is required.

Examples are handling of acids and caustics, dipping in galvanizing tanks and some japanning operations.

GROUP F.—Processes where protection from an excessive amount of dust and small flying particles is required.

An example of these processes is sand-blasting.

GROUP G.—Operations where protection is required from reflected light or glare.

Examples are long exposure to snow-covered ground, exposure to reflected sunlight from roofs, roadbeds, etc.

GROUP H.—Processes where protection from injurious radiant energy with a moderate reduction in intensity of the visible radiant energy is required.

Examples are oxy-acetylene and oxy-hydrogen welding and cutting; open-hearth, Bessemer, and crucible steel making; furnace work, electric resistance welding, brazing, and testing of lamps, involving exposure to excessive brightness.

GROUP I.—Processes where protection from injurious radiant energy with a large reduction of the visible radiant energy is required.

Examples are electric arc welding and cutting.

Protection to the head should be provided in certain other kinds of work. Some form of reinforced head covering giving protection to the head from severe blows is recommended wherever falling objects are liable to strike workers, as in some conditions of building construction, mining, and shipbuilding. Caps or nets covering the hair are recommended for operators in shops where there is moving machinery or power-transmission apparatus in which their hair might become entangled.

12. Definitions.

Protector.—A protector is a device which is placed in front of the eyes, face, or head to afford protection from the hazards in industrial processes or from the natural elements.

Goggles.—Goggles are an optical device worn before the eyes, whose predominant function is protection to the eyes only.

Face Mask.—A face mask is a device worn before the eyes and a portion or all of the face, whose predominant function is protection to the eyes and face.

Helmet.—A helmet is a rigid device worn by the operator, which shields the eyes, face, neck, and a portion or all of the other parts of the head and is held in place by suitable means.

Hood.—A hood is a device which completely covers the head, neck, and portions of the shoulders so as to exclude dust and flying particles.

Shield.—A shield is a device to be held in the hand, or supported without the aid of the operator, whose predominant function is protection to the eyes and face.

13. Classification of Protectors.

The face mask, helmet, shield, and hood types of protectors are referred to in these rules by name.

For the purpose of clearly defining the application of the styles of goggles to the processes given in rule 11, and for clearly differentiating between the tests which are to be applied to them, goggles shall be considered as falling in two main classes, namely, rigid-front goggles and goggles with flexibly connected lens containers. Included in the class of goggles with rigid fronts are the nonadjustable rigid-bridge type and the adjustable metallic-bridge type of goggles, in both of which the bridge is rigidly fastened to the lens container. The flexibly connected type of goggles consists of those which have a flexible connecting link between the lens containers. The link is usually of leather, but any other material of equal serviceability may be used.

Goggles shall be designated according to styles as follows:

Style 1.—Goggles having rigid nonadjustable bridge (or adjustable metallic bridge) without side shields.

Style 2.—Goggles having rigid nonadjustable bridge (or adjustable metallic bridge) with side shields.

Style 3.—Goggles having flexibly connected lens containers shaped to conform to the configuration of the face.

14. Lenses for Persons Having Defective Vision.

Employees whose vision requires the use of corrective lenses in spectacles, and who are required by these rules to wear protective goggles, shall be provided with goggles to be worn over the corrective spectacles. The goggles shall be so arranged that the optical adjustment of the spectacles will in no way be disturbed. In lieu of such goggles, employees may be provided with goggles whose lenses provide the proper optical correction, but these lenses need not be subjected to the drop test as required by rule 21 (*b*). Where corrective lenses are used they shall be so marked that improper adjustment will be avoided.

15. Replacement of Lenses.

Protectors, the lenses of which may be replaced, shall be so designed that this may be accomplished without the use of tools of special character and design.

Lenses, or windows, and lens containers should be substantially uniform as to dimensions so as to facilitate the replacing and interchanging of lenses. The employer shall be responsible for the proper replacement of lenses upon application of an employee.

16. General Requirements for Glass.

(*a*) *All Glass.*—Glass for lenses and windows of protectors shall be hard, substantially free from striæ, air bubbles, waves, and other flaws. The front and rear surfaces shall be smooth and substantially parallel, except where the lens is ground to provide proper optical correction for defective vision.

(*b*) *Goggle Lenses.*—All lenses shall have dimensions not less than 1.5 inches (38 mm) in the vertical direction and 1.75 inches (44.5 mm) in one horizontal direction.

SEC. 2. PROTECTORS FOR CHIPPERS, RIVETERS, CALKERS, ETC.

GROUP A.

20. Styles Permitted.

Goggles of styles Nos. 2 and 3, face masks and helmets are the only permissible styles.

21. Specifications and Tests for Lenses.

(*a*) *Specifications.*—Lenses shall transmit not less than 70 per cent of the visible light from the standard source specified in rule 124 (*a*). (See also rule 16.)

Each lens shall bear some permanent distinctive marking by which its source may be readily identified.

(*b*) *Test.*—Samples of lenses for use in operations included in Group A shall be submitted to the tests described in rule 123 to determine their quality. Lenses which have been submitted to the drop test shall not be used in service.

22. Goggles of Style No. 2.

(*a*) *Frames.*—Frames shall be made of a material that will withstand sterilization and will not readily corrode and will not discolor the skin. Frames shall have a smooth finish.

(*b*) *Lens Containers.*—Containers shall be suitable for holding lenses of dimensions specified in rule 16.

(*c*) *Side Shields.*—If goggles are provided with side shields, such shields shall be made of metal, leather, or other material of suitable durability. No quick-burning material shall be used. The material shall be sufficiently pliable to permit adjusting the shield to the contour of the face. The edges coming in contact with the face shall be finished in a manner to prevent irritating or cutting the skin. If the side shields are of metal, they shall be of wire mesh or of perforated sheet having openings not larger than 0.0394 inch (1 mm). Adequate ventilation shall be provided.

The construction of the goggles shall be such as to permit the folding of the temples so that they may be stored in a case or container.

(*d*) *Temples.*—Temples shall be made of a material which can be sterilized without deterioration and will not readily corrode and will not discolor the skin. Ear hooks for temples shall be flexible, properly formed to fit the ear, and so finished or covered as not to cut or irritate the skin. No quick-burning material shall be used. If a covering be used, it shall extend for half the length of the temple and be of a material which will not readily deteriorate in service. The screw or rivet which fastens the temple to the frame shall not also be used to hold the lens in the container.

(*e*) *Short Temples.*—Short temples may be substituted for full-length temples. They shall be made of a material that will not readily corrode and will not discolor the skin. They shall be attached to the frame in the same manner as and be interchangeable with the full temples. A head band shall be fastened to the outer ends of the short temples and shall be adjustable as to length and easily replaceable.

(*f*) *Headband or Headgear.*—In lieu of full temples or short temples, a headband or headgear of any suitable material and design may be supplied that will properly retain the goggles in position and afford comfort and protection to the wearer. Such headgear shall be adjustable as to size or shall be supplied in properly assorted sizes.

(*g*) *Connection between Lens Containers.*—Nose pieces, bridges, or connecting links between lens containers shall have the portions that come in contact with the skin of a material that will not readily corrode and will not discolor the skin. The construction shall be substantial and the nose piece, bridge, or connecting link shall be securely fastened to the lens containers. If the weight of the goggle is borne by the bridge or nose piece resting on the crest or sides of the nose of

the wearer, these portions of the goggles shall have broad comfortable surfaces. The nose piece, bridge, or connecting link shall be so constructed as to be readily adjustable, or the goggle shall be furnished in assorted sizes.

(*h*) *Marking.*—Each frame shall bear some permanent distinctive marking by which its source may be readily identified.

23. Goggles with Flexibly Connected Lens Containers, Style No. 3.

(*a*) *Eyecups.*—Eyecups shall be made of rigid, noninflammable material that will not readily corrode and will not discolor the skin and can be sterilized without deterioration. They shall be shaped to conform to the configuration of the face and shall have edges which will not cut the face. Proper ventilation shall be provided and the goggles shall be fitted with a headband or headgear of cloth, leather, or other suitable material, which will retain them in their proper position with reasonable comfort.

(*b*) *Lens Containers.*—Containers shall be suitable for holding lenses of dimensions specified in rule 16 (*b*). They should be designed to permit easy replacement of lenses.

24. Test for Frames.

The frames of goggles of style No. 2, having either adjustable or rigid bridges, used in processes included in Group A, shall withstand the tests prescribed in rule 121 (*c*) and (*d*). The frames of protectors having rigid bridges used in processes included in Group A shall also withstand the tests prescribed in rule 121 (*a*) and (*b*). The frames of goggles of style No. 3, if used in operations included in Group A, shall withstand the tests prescribed in rule 121 (*c*).

All goggles used in processes included in Group A shall withstand the corrosion test prescribed in rule 122, if the

metal comes in contact with the skin. When padding is used to prevent such contact this test may be omitted.

If face masks or helmets are used, the lens containers shall be of such strength as to withstand the equivalent of the strength test prescribed in rule 121 (*c*).

SEC. 3. PROTECTORS FOR SCALING, GRINDING, ETC.

GROUP B.

30. Styles.

Goggles of styles Nos. 1, 2, and 3, are permissible styles. They need not comply with any strength tests.

31. Specifications for Lenses.

Lenses shall transmit not less than 70 per cent of the visible light from the standard source specified in rule 124 (*a*). (See also rule 16.)

32. Goggle Frames.

(*a*) *Styles Nos. 1 and 2.*—Frames of goggles of styles Nos. 1 and 2 for this class of service shall comply with rule 22 (except that the requirements of 22 (*c*) for side shields do not apply to goggles of style No. 1).

(*b*) *Eyecup Goggles.*—Eyecup goggles shall conform to the requirements of rule 23.

SEC. 4. PROTECTORS FOR EXPOSURE TO DUST AND WIND, ETC.

GROUP C.

40. Styles.

Goggles of styles Nos. 1, 2, and 3 are permissible styles. They need not comply with any strength tests.

41. Specifications.

(*a*) *Goggle Frames.*—Frames and temples shall be substantially made. Eyecup goggles shall comply with rule 23.

19579—23——2

(*b*) *Lenses.*—Lenses shall transmit not less than 70 per cent of the visible light from the standard source specified in rule 124 (*a*). (See also rule 16.)

SEC. 5. PROTECTORS FOR BABBITTING, ETC.

GROUP D.

50. Styles.

A face mask and goggles of styles Nos. 1, 2, and 3 are permissible styles. They need not comply with any strength tests.

51. Specifications for Masks.

Face masks may be of woven wire, the openings of which shall not exceed 0.0295 inch (0.75 mm), vulcanized fiber, or equivalent material which can be sterilized without deterioration.

Masks shall be designed to hold lenses of dimensions specified in rule 53.

52. Specifications for Goggle Frames.

Frames of goggles of styles Nos. 1 and 2 shall conform to the requirements of rule 22 (except that the requirements of rule 22 (*c*) for side shields do not apply to goggles of style No. 1). Goggles of style No. 3 shall conform to the requirements of rule 23.

Lens containers shall be so constructed as to retain the parts of the lens in position if it should become cracked.

53. Specifications for Lenses.

Lenses shall have a thickness not less than 0.079 inch (2 mm).

If a single window is used in place of separate lenses, it shall have dimensions not less than 4.25 inches (10.8 cm) in one horizontal direction and not less than 2 inches (5.1 cm) in the vertical direction.

Lenses shall transmit not less than 70 per cent of the visible light from the standard source specified in rule 124 (*a*). (See also rule 16.)

SEC. 6. PROTECTORS FOR HANDLING CORROSIVE CHEMICALS, DIPPING, BRUSH COATING, ETC.

GROUP E.

60. Styles.

Eyecup goggles of style No. 3, face masks, and hoods are permissible styles. They need not comply with any strength tests.

61. Specifications for Goggles.

(*a*) *Goggles for Handling Acids, Caustics, etc.*—Eyecups shall be of soft pliable rubber or equivalent noninflammable material and shall be flexible enough to conform readily to the configuration of the face. A suitable headband or headgear shall be provided, and it shall be impossible for splashing liquids to enter the eyes through the openings provided for ventilation. Where the presence of fumes would cause discomfort to the wearer if ventilating ducts were provided, goggles without ventilating openings shall be used.

(*b*) *Goggles for Use in Dipping and in Brush Coating.*—Eyecups shall conform to the requirements of rule 23. The design having solid eyecups except for a single ventilating opening near the lens is preferable. If the volume of fumes arising from the work is great, the eyecups shall be padded so that they fit the face closely.

62. Specifications for Face Masks.

Face masks shall be of metal, vulcanized rubber, fiber, or equivalent material and shall have no openings in the front of the mask other than required for lenses. Masks shall be so shaped as to effectively protect the entire face.

63. Specifications for Hoods.

Hoods shall cover the head and neck completely and shall extend below the shoulders so as to effectively exclude gases.

Ventilation may be secured from an external source, the air being conducted to the operator by means of a hose. The air pressure should be so reduced and the distribution of the air within the hood should be such that the employee is not subjected to physical discomfort during or as a result of his work. It is recommended that a separator trap be provided on the air line for the removal of oil, water, and other extraneous matter.

64. Specifications for Lenses.

If a single window is used in place of separate lenses, it shall have dimensions not less than 4.25 inches (10.8 cm) in one horizontal direction and not less than 2 inches (5.1 cm) in the vertical direction.

Lenses shall transmit not less than 70 per cent of the visible light from the standard source specified in rule 124 (*a*). (See also rule 16.)

For processes which will undesirably affect the surface of the glass either by deposits or chemical action, lenses of other material than glass, suitable for the process concerned, may be used. Lenses of cellulose acetate or other material substantially free from striæ, air bubbles, waves, and other flaws may be used.

SEC. 7. PROTECTORS FOR SANDBLASTING.

GROUP F.

70. Styles.

A hood is the only style permitted.

The use of sandblast cabinets so arranged that the operator can stand on the outside and direct the nozzle through an opening, observing the operation through a suitable window, is recommended. In this case no hood is required.

71. Specifications.

Hoods shall cover the head and neck completely and shall extend below the shoulders, so as to effectively exclude dust and small particles.

A window of metal screen having openings not larger than 0.0295 inch (0.75 mm) shall be used. This window may be furnished with a glass lens inside of the metal screen. If no glass is used for the window, a suitable respirator shall be provided to filter the air.

Ventilation may be secured from an external source, the air being conducted to the operator by means of a hose. The air pressure should be so reduced and the distribution of the air within the helmet should be such that the employee is not subjected to physical discomfort during, or as a result of, his work. It is recommended that a separator trap be provided on the air line for the removal of oil, water, and other extraneous matter.

SEC. 8. PROTECTORS FOR EXPOSURE TO GLARE.

GROUP G.

80. Styles.

Goggles of styles Nos. 1, 2, and 3 are permitted. They need not comply with any strength tests.

81. Specifications.

(*a*) *Frames.*—The frames of goggles shall be substantially constructed.

(*b*) *Lenses.*—Lenses shall meet the tests for transmission of radiant energy prescribed in rule 124 (*b*). (See also rule 16.)

SEC. 9. PROTECTORS FOR OXY-ACETYLENE WELDING, FURNACE WORK, ETC.

GROUP H.

90. Styles.

Goggles of styles Nos. 1, 2, and 3, face masks, helmets, and shields are permitted. They need not comply with any strength tests.

91. Goggles of Styles No. 1 or 2.

The frames shall conform to the specifications given in rule 22 (except that the requirements of rule 22 (*c*) for side shields do not apply to goggles of style No. 1). To prevent burning, a heat-insulating material which can be sterilized without deterioration shall be used on all parts touching the face.

92. Eyecup Goggles, Style No. 3.

Goggles shall consist of eyecups of noncorrodible opaque material, which can be sterilized without deterioration. They shall be shaped to fit the configuration of the face. They shall exclude light, except through the lenses, but shall afford adequate ventilation. Parts touching the face shall be made of heat-insulating material. The eyecups shall be connected by a flexible coupling which will permit ready adjustment, or else goggles shall be furnished in assorted sizes.

The coupling shall be covered with or made of heat-insulating material. It shall withstand sterilization or be easily renewable. Goggles shall have a headband or headgear of any suitable material which will retain the goggles in their proper position. Each pair of goggles shall bear some permanent distinctive marking by which its source may be readily identified.

93. Face Masks.

(*a*) *Masks and Headgear.*—Face masks shall be of fiber or equivalent material, which can be sterilized without deterioration and be shaped so as to protect the face of the operator above the mouth. Face masks shall have a headband or headgear of any suitable design and material so as to retain the mask in proper position. Each face mask shall bear some permanent distinctive marking by which its source may be readily identified.

(*b*) *Lens Containers.*—If a single window is used in place of separate lenses, it shall hold glass the dimensions of which are not less than 4.25 inches (10.8 cm) in one horizontal direction and 2 inches (5.1 cm) in the vertical direction. Containers shall be designed to accommodate cover glasses to protect the lenses. The design shall permit ready renewal of lenses.

94. Helmets.

Helmets of the design specified in rule 101 (*b*) are permitted.

95. Specifications and Tests for Protective Glass.

(*a*) *Optical.*—Lenses shall meet the transmission test for radiant energy prescribed in rule 124 (*c*).

Lenses constructed of two parts may be used if the lower half conforms to the requirements of rule 124 (*c*).

(*b*) *Marking.*—Glasses, except cover glasses, shall bear some permanent distinctive marking by which the source may be readily identified.

(*c*) *Cover Glasses.*—Cover glasses should be provided to protect the lenses. They shall be substantially free from striæ, air bubbles, and other flaws, and shall have substantially parallel surfaces. (See also rule 16.)

SEC. 10. PROTECTORS FOR ELECTRIC ARC WELDING AND CUTTING.

GROUP I.

100. Styles.

The helmet and the shield are the only permissible styles.

101. Specifications for Protectors.

(*a*) *Helmets.*—Helmets shall be made of a material which is an insulator for heat and electricity and shall be capable of withstanding sterilization. They shall be arranged to protect the face and ears from direct radiant energy from the arc. Helmets shall be provided with one or two windows

arranged to accommodate and hold securely window glasses of the dimensions specified in rule 102, single or multiple, with cover glass, and designed to permit easy renewal of the glasses. Absorptive glasses shall be so mounted as to be not less than 2 inches (5.1 cm) from the eyes.

When supported by headgear the weight of the helmet complete shall not exceed 24 ounces (680 g).

(*b*) *Shields.*—The shield shall consist of opaque material which is an insulator for heat and electricity. It shall be of such size and so shaped that it will protect the face from all direct radiant energy and shall be provided with a single window of the dimensions specified in rule 102, fitted to carry glasses single or multiple.

102. Specifications and Tests for Windows.

(*a*) *Optical.*—Windows shall meet the tests for transmission of radiant energy prescribed in rule 124 (*d*). (See also rule 16.)

(*b*) *Dimensions.*—Windows for both helmets and shields shall have height not less than 1.75 inches (4.4 cm) and width not less than 3.75 inches (9.5 cm) where one window is provided, or 1.75 inches (4.4 cm.) where two windows are provided. These dimensions apply to the opening unobstructed by any opaque substance.

(*c*) *Marking.*—Glasses, except cover glasses, shall bear some permanent distinctive marking by which the source may be readily identified.

(*d*) *Cover Glass.*—A cover glass should be provided to protect the lenses. It shall be substantially free from striæ, air bubbles, and other flaws, and shall have substantially parallel surfaces.

103. Protection for Other Workers.

A guard or shield shall be provided where necessary to protect other workers from exposure to the radiation from

the electric arc, and no employee shall be required to work in such a position that his face is exposed to such radiation from any neighboring source.

It is recommended that permanent inclosures be supplied, where practicable, for arc welding and cutting.

SEC. 11. OPERATING RULES.

110. Sterilization.

Goggles shall not be interchanged among employees unless they have been sterilized. The following methods for sterilization are recommended:

(1) Goggles, parts of which would ordinarily deteriorate if sterilized by either of the following methods, may be sterilized by an antiseptic gas for a period of 10 minutes. An atmosphere of formaldehyde is recommended.

(2) Goggles and cases shall be placed in boiling water for a period of 5 minutes.

(3) Goggles shall be placed for 10 minutes in a solution of formalin made by placing 0.106 ounce (3 g) of 40 per cent formaldehyde in a quart of water.

111. Supply and Fitting of Goggles.

The employer shall advise his employees where within the works protectors may be obtained, and employees shall not be put at work where protectors are needed without being provided with them. Care shall be exercised to properly adjust protectors which are not an exact fit, to secure the greatest comfort consistent with adequate protection. Particular attention should be given when fitting goggles to be sure that the eyelashes of the wearer do not touch the surface of the glass.

A duly appointed agent or employee should be assigned the duty of distributing and fitting eye protectors as a result of indicated or demonstrated ability to perform this duty efficiently.

112. Replacement of Defective Protectors.

The employee shall be responsible for immediately reporting any broken or otherwise defective protectors, and for making application to the employer for their repair or replacement.

The employer shall be responsible for the proper replacement of protectors or their defective parts.

Employees shall never wear defective protectors. Broken or damaged parts shall be replaced by new parts before the protectors are again used.

113. Inspection of Protectors.

It is recommended that periodical inspection of all protectors be made by the employer or his authorized representative so that the wearing of protectors in good condition will be assured.

114. Cases.

A suitable individual unlined metal case with rounded corners, capable of withstanding sterilization, should preferably be furnished to each employee using goggles.

115. Supply of Protectors or Repair Parts.

Employers shall keep an adequate supply of protectors or repair parts in stock at all times.

Where rigid nonadjustable goggles are used, assorted sizes shall be kept in stock at all times.

SEC. 12. TESTS FOR FRAMES AND GLASS.

120. Scope of Tests.

The following tests for the frames and glass of protectors are intended to assure adequate strength and other qualities of protectors used in those processes named in the rules of the foregoing sections in which tests are required. The number of frames, lenses, or windows to be tested shall be determined by the proper administrative authority.

121. Mechanical Tests for Frames of Goggles.

(*a*) *Flat Transverse Test.*—Each frame tested shall have the right lens container laid flat, with the outer surface of the lens downward, on a firm level support so that the left lens and one-half of the bridge projects beyond the edge of the support and shall be held in this position. A spring balance shall be attached to the outermost portion of the frame of the left lens, and a downward force of 8 ounces (226 g) shall be applied while the right lens frame is rigidly held. After removal of the load no permanent deformation shall be apparent in the frame.

(*b*) *Edge Transverse Test.*—Each frame tested shall have the right lens container held vertically in one hand and the lower edge of the left lens container, as worn, pressed against one of the platforms of an equal-arm balance having a weight of 4 pounds (1.82 kg) on the other platform. The pressure shall be increased until the weight is balanced, whereupon the frame is removed and examined. No permanent deformation shall be apparent in the frame.

(*c*) *Strength Test for Lens Containers.*—Lens containers shall be substantial in construction and each container tested shall withstand, without distortion, the drop test prescribed in rule 123.

(*d*) *Test of Joints.*—If the lens containers are rigidly joined by a separate bridge or nose piece in any manner whatsoever, the joints shall be given the following tests to demonstrate their strength and durability. Goggles which have already passed the strength tests of paragraphs (*a*), (*b*), and (*c*) above may be used for this purpose. The lens containers with lenses in place shall be gripped one in each hand, the thumbs bearing on the outer surface near the bridge and the fingers on the inner surface of the lenses near the junction of the bridge and the lens container. The frames shall then be slowly bent, the direction of motion being in a plane perpendicular

to the surface of the lenses, until the outer surfaces of the lenses face each other, the outer ends of the frames touching. The frames shall then be bent back to their original shape and a careful inspection made for failure in the joints. All frames tested shall pass this test without developing visible cracks.

If the bridge is constructed with individual members of the bridge in more than one plane parallel to the surface of the lenses, all of the members except those attached to the rims of the lens containers shall be cut and the above test applied to the remaining members.

122. Test for Corrosion.

The corrodibility of the metal of the frame and side shields shall be determined by immersing a pair of goggles in a boiling aqueous 10 per cent (by weight) solution of sodium chloride for a period of 15 minutes. The frames upon being removed from this solution shall be immediately immersed in a 10 per cent (by weight) aqueous solution of sodium chloride at room temperature. They shall then be removed from this solution and, without having the adhering liquid wiped off, allowed to dry for 24 hours at room temperature. The metal parts shall then be rinsed in lukewarm water and allowed to dry. On inspection the surface shall still be smooth.

123. Mechanical Tests for Lenses.

Drop Test.—Lenses shall be submitted to either of the two following tests to determine the quality of material used in the manufacture of such lenses, and are acceptable if they pass either test.

(1) A spherical steel ball 0.565 ounce (16 g) in weight, approximately 0.625 inch (1.59 cm) in diameter (weight must be correct within 2 per cent), shall be dropped 10 times from a height of 21.2 inches (54 cm) on the center of the horizontal outer surface of the lens when held in the frame. The lens shall be supported by the rim of the container only, on a rubber washer 0.25 inch (6.4 mm) thick, secured to the

top of a board or block of wood. If one out of six lenses is fractured in this test, four more lenses shall be tested, and if any one of these is fractured, the lot shall be rejected.

(2) A spherical steel ball 0.565 ounce (16 g) in weight, approximately 0.625 inch (1.59 cm) in diameter (weight must be correct within 2 per cent), shall be dropped once from a height of 39.37 inches (1 m) on the center of the horizontal outer surface of the lens when held in the frame. The lens shall be supported by the rim of the container only, on a rubber washer 0.25 inch (6.4 mm) thick, held upon the top of a board or block of wood. If one out of six lenses tested is fractured in such a way that a fragment of glass weighing more than 0.39 grain (25 mg) leaves the bottom surface, four more lenses shall be tested, and if one of these lenses fractures in the above-described manner the lot shall be rejected.

124. Optical Tests for Lenses.

(*a*) *Standard Source of Radiant Energy.*—The standard source of radiant energy used for the measurement of transmission of visible light or total radiant energy shall be a 200-watt, 110-volt, gas-filled, tungsten-filament, electric incandescent lamp operating at 0.8 watt per spherical candle (approximate commercial rating).

(*b*) *Lenses for Group G.*—Lenses shall transmit not more than 1 per cent of radiant energy of any wave length less than 365 millimicrons. They shall transmit not more than 50 per cent of the visible light incident upon them from the standard source.

(*c*) *Lenses for Group H.*—Lenses or helmet windows shall transmit not more than 1 per cent of radiant energy of any wave length less than 365 millimicrons. They shall transmit not more than 50 per cent of the total radiant energy incident upon them from the standard source.

(*d*) *Windows for Group I.*—Helmet windows shall transmit not more than 1 per cent of radiant energy of any wave

length less than 405 millimicrons and not more than 0.2 per cent of wave lengths 313 and 365 millimicrons. They shall transmit not more than 1 per cent of the visible light and not more than 30 per cent of the total radiant energy incident upon them from the standard source.

DISCUSSION OF THE RULES.

SECTION 1. GENERAL REQUIREMENTS.

The need for definite requirements to protect the eyes of industrial workers is well illustrated by the statistics of accidents and compensation in those States where full accident reports are regularly made. In the year 1918 there occured in the State of Pennsylvania 705 industrial accidents resulting in the loss of one or both eyes. In the year 1920 there were 670 such accidents. In the year 1919 in Wisconsin there were 589 eye accidents of which 60 resulted in permanent injury. In 1920 there were 148 resulting in permanent injury. The record for five years in California shows a yearly average of 10,470 accidents to the eye of which 206 resulted in permanent injury. In the year 1918 there were 251 resulting in permanent injury. The cost for compensation and for medical service in that State for that year amounted to $457,799. The National Safety Council has estimated that for the entire United States there are annually about 200,000 industrial accidents resulting in eye injury.

Eye accidents reported are almost entirely of a mechanical nature and include very few cases of a pathological nature. This is partly due to the fact that it is not only hazardous, but uncomfortable and inconvenient as well, to expose the eye to dangerous sources of light. Goggles or helmets are almost invariably used in welding work, but even where injury to the eye results from such exposure, the effect is not instantaneous and sensational; no notice of it may be taken by a workman's

companions; no first aid is extended, and perhaps no report is made. If the injury is not severe, the eye will recover, so that the damage is not permanent and probably no claim for compensation is made.

The mechanical hazards to the eye are such as frequently to go without attention in a particular shop until an accident occurs. Even in shops where goggles are provided, workmen frequently go unprotected, hence, whereas shops providing goggles are likely to have a lower rate of eye injury than others, this rate will not be entirely wiped out until the use of protectors in hazardous processes becomes universal.

The Pennsylvania Railroad has an active safety department and furnishes goggles to shop workers, yet in the year 1918, 4.6 per cent of the injuries reported on the eastern lines were eye injuries. The United States Steel Corporation reports 5.1 per cent of all accidents as causing injury to the eye. Almost invariably such injuries occur to men who fail to wear protectors, making the need of special attention to this subject by shop superintendents and perhaps with the additional incentive of legal compulsion very urgent. It is very seldom that a workman wearing protectors loses an eye, but occasionally a blow on the eye is so severe that no available goggles give protection. It is not possible to protect at all times against such unusual conditions, but the rules and strength tests have been devised to give protection under ordinary working conditions. In industrial plants where the use of goggles has been systematically carried out, it is reported that the eye injuries have been reduced in different establishments by amounts varying from 75 to 100 per cent.

10. Scope, Application, and Compliance.

The scope of these rules is confined to industrial operations. Valuable guidance will be found for protection in other occupations, military, naval, sporting, etc., such as military

expeditions over snow-covered ground. There are definite occupations, however, such as aviation, not yet of an industrial or commercial character, in which protection to the head and eyes may be required, which are not definitely included in the scope of the rules.

It is obvious that those operations which provide their own protection from flying particles or from other possible source of injury to the head and eyes should not be hampered by the requirement to furnish and wear goggles in addition. Examples of such equipment are grinding wheels furnished with a glass shield behind which the operation is carried on, and the sand-blast cabinet which is so arranged that the operators stand outside and work through suitable apertures in the wall.

Operations can be divided into two general classes, namely, those where it is essential that the workers wear proper protectors, and those where it is optional with the workers to wear protectors. Examples of the first class are chipping and arc welding. Examples of the second class are automobile driving and exposure to glare. Obviously it is necessary that a proper supply of protectors be kept on hand. The employer should feel it incumbent upon him to so organize his work in all departments as to require workers to wear the proper protectors and not depend on the worker to judge whether the occupation in which he is engaged is of such nature as to require the use of protectors. On the other hand, the hazard involved in such occupations as auto driving is not great except under severe weather conditions. The worker recognizes the necessity for protection in these cases, since without the use of protectors physical discomfort ensues. He will accordingly request proper protectors, particularly where it is well understood that it is the established policy to furnish them on demand.

Where devices are available which have been subjected to examination by some properly qualified body and found to comply with the general requirements of this code, such devices should be used in preference to others which have not been so examined regarding their suitability for the given purpose.

In order to avoid the necessity for repetition of such examination by different examiners, frequently with inadequate facilities for such work, and to avoid the confusion which would result over conflicting reports as to the suitability of devices examined for a given purpose, it is desirable that such examinations should be made under standard conditions, and the record made generally available through promulgation by organizations properly equipped and qualified for experimental testing, inspection of the run of goods at factories, and service-value determinations through field inspections, and whose findings are subject to appeal to the Bureau of Standards.

11. Classification of Operations and Processes.

The use of goggles and other protectors in industries where processes are carried on which involve hazard to the head and eyes is widespread, especially in works such as the steel plants, which have organized for safety. The operations and processes which are so hazardous as to make it desirable for workmen to be provided with special protection to the head and eyes are varied. Therefore no attempt has been made to name the specific operations or processes against which protection should be given, but rather an attempt has been made to classify the character of the hazards which are existent in industry, leaving it to the employer, or the administrative authority, or other responsible party to assign the particular operation concerned to its proper group.

19579—23——3

The various operations and processes which require protection to the head and eyes have been classified into nine groups according to the degree of hazard or because the peculiar nature of the hazard makes it necessary to provide a protector having distinctive features.

The hazards from flying solid particles ordinarily encountered are separated into three groups designated A, B, and C. The first group will contain all operations wherein the mechanical hazard is so great as to warrant the selection of protectors the parts of which have passed mechanical tests assuring adequate strength. In class B are grouped all operations in which the protector must prevent the entrance of small flying particles into the eye. The lens will not be subjected to severe blows and hence no mechanical tests are necessary. While strength of the frames of goggles used for this purpose is not a prime requisite, definite requirements for the material entering into their construction is necessary. Hence a separate group for these processes has been made. In class C, occupations similar to auto driving, protectors are used merely to keep small foreign particles out of the eyes and hence the protector need not withstand any special strength tests.

In processes where splashing metal is used the special hazard is from burns from molten metal which might be projected with force. The degree of hazard varies with the operations and therefore a number of different methods of protection are suitable. Workers handling fumes, gases, and liquids require protectors of various designs, each one having protective qualities peculiarly fitted for the work. These operations have accordingly also been classed in a separate group.

The hazards incident to sand-blasting are not met in any other process. Hence this subject is treated separately.

In the last three groups are classified all of the operations where the worker is exposed to harmful radiant energy.

Definite limits to the transmission of the radiant energy through the lens or window of the protector have been set. These limits are based on the degree of hazard involved, an analysis of which results in the division of hazards into three groups.

The conditions under which protection to the head is desirable can not be so definitely defined as to make a mandatory rule on this subject practicable. Some judgment must be exercised as to whether protection against falling objects is warranted. Where women workers are employed in shops, the hair should always be protected from dust and from the danger of catching in machinery by a light-weight comfortable cap, which may be made of cambric or glazed muslin. Under no circumstances should girls be allowed to work near machinery with the hair streaming or fluffed out several inches from the head. Head covering is equally necessary for fire protection where inflammable vapors or gases are present.

12. Definitions.

Under this rule are defined all of the devices used for protective purposes referred to in the rules. In general, the intention has been to define them in terms of the purpose to be attained rather than to define them in terms of their design features. In order to avoid confusion the word helmet is restricted to a protector which does not necessarily completely cover the head, whereas the hood does.

13. Classification of Protectors.

The types of protectors in use vary in shape and construction according to the use for which they are designed. For use in certain operations protection to the head is required, whereas in others protection to the eye is all that is required. The designs of protectors which may be used to mitigate the hazards incident to a process or operation are varied. To insure adequate strength regardless of the design, cer-

tain strength tests are prescribed in the rules for protectors which might be subjected to severe blows, namely, those included in group A. For the purpose of distinguishing between the different forms and shapes of goggles, they have been classified according to design and a style number assigned to each class. This designation has no reference to strength or ability to meet tests. This avoids confusion when referring to the style of goggles whose use is permitted for a given kind of work and in differentiating between the tests to be applied to them.

14. Lenses for Persons Having Defective Vision.

There is a difference of opinion among safety engineers as to the best method to pursue to give employees who have defective eyesight proper protection when their work is such that it could be properly classified in the groups mentioned in rule 11. There is general agreement that the spectacles the worker ordinarily wears do not give sufficient protection, at least for most of the groups. Goggles should be furnished and worn over the spectacles, or else the lenses of the goggles should be ground to provide the proper optical correction. The latter method is looked upon with disfavor by many, but it is permitted as an alternative owing to the objections to wearing two frames.

Corrective lenses are exempted from the drop test because they are ground to individual order, and a lens which has been tested, even though it does not break, should not be used. Care should be taken that specimen blank lenses do, however, meet the drop test prescribed in rule 123.

15. General Recommendations.

Some employers prefer to use goggles of such a design that the lenses are permanently and securely held in the frame and are not replaceable except by the employment of special

means. Broken goggles are allowed to accumulate, broken ones being replaced by new goggles, until a large order can be sent to the manufacturer for replacement of lenses.

On the other hand, other employers prefer to replace their own lenses, in which case it is desirable that this may be easily done in order to discourage the retention in service of broken goggles. Goggles whose lenses may be replaced merely by unscrewing a portion of the lens container, by the proper manipulation of specially constructed parts of the frame, or by the use of a tool generally available, such as a screw driver, are suitable. To prevent the unintentional replacement of an unsuitable lens, lenses which meet special requirements must be marked (see rules 21 (*a*), 95 (*b*)).

It is desirable that lenses and lens containers of goggles designed for a given operation be made uniform as to dimensions so that they may be readily interchanged or replaced. Some manufacturers prefer to use a specially designed size or shape for processes involving hazards of one degree and a different size or shape for hazards of another degree.

16. General Requirements for Glass.

In this rule are grouped all of the general requirements for glass which apply to lenses and windows regardless of the processes in which employed, and whether they be used for mechanical protection or where radiant energy must be intercepted.

There is no uniformity among manufacturers of goggles as to size or shape of lenses. It seemed justifiable to place a minimum on the sizes of lenses since an adequate field of vision is necessary. In certain operations it may be desirable to exceed these dimensions, particularly when the protector is placed at a greater distance from the eye than is contemplated in the use of the goggle.

SEC. 2. PROTECTORS FOR CHIPPERS, RIVETERS, ETC.

20. Styles Permitted.

Goggles used in such operations as chipping and riveting may be subjected to blows directed from any position in front of the operator. This makes it necessary for chippers' goggles to give side protection. This may of course be accomplished by using side shields or the eyecup style of goggle.

21. Specifications and Tests for Lenses.

A high percentage transmission of light is of importance for this class of work. Almost any lens made of so-called "colorless" glass will transmit more than 80 per cent of the incident light. Laminated lenses consisting of two glass elements held together by a layer of other material may not have transmission quite so high, so that the limit has been placed at 70 per cent. The latter may become cloudy when subjected to heat, depending on the material which is used between the glasses and the method of sealing the joints. These should not be used when working in processes where they might be subjected to high temperature. Sterlization in hot water may similarly result in deterioration. Before such deterioration has become so pronounced as to interfere with vision the transmission will have diminished to a value less than 70 per cent and this rule will consequently bar such lenses from use.

Lenses for chippers' goggles must withstand certain strength tests. In order to properly identify them it is desirable therefore that they be plainly marked.

The relatively severe blows to which chippers' goggles are likely to be subjected, and should therefore be required to withstand, makes it necessary to prescribe a strength requirement for protectors used in operations involving this hazard. The requirement is of the nature of a mechanical test to which a certain portion of the goggles to be used for this

service are subjected. Like all other mechanical tests which are of such nature that the object under test is destroyed or damaged, the quality of the lot must be judged by the performance of a portion selected for test. A discussion of the test is given under rule 123. It has been found that repeated blows alter the character of glass, making it more liable to fracture. Hence a tested lens should not be used for protection; neither should one which has received a severe blow in service.

22. Goggles of Style No. 2.

Side shields are necessary in order that flying particles can not enter the spaces around the lens container. They may, of course, be solid or perforated but, if perforated, the holes should not be large enough to allow particles to enter. The frames of goggles should be of light substantial material. The principal requirements are comfort to the wearer and strength enough to withstand the service. This service requirement is determined by a strength test of the lens containers and the frames.

24. Test for Frames.

The test for the lens containers is such as to insure the retention of the parts of the lenses, in case of breakage, in the container. The container should, therefore, withstand without deformation the drop test for lenses. In order to insure a reasonable life and strength of frames, which when subjected to severe blows will not be distorted unduly, it is necessary to prescribe certain tests for frames which are minimum requirements. These tests are different for the different styles of goggles. A further discussion of the test for frames is given under rule 121.

Frames should be made of a material that will withstand sterilization. Sterilization is necessary because there may be interchange of goggles among employees. The material

should be such that it will not react chemically with the perspiration from the skin. Such action, if it occurred, might cause irritation or discoloration. For the same reason the material should not readily corrode. Discoloring of the skin is objectionable to the worker and should be avoided.

The corrosion test has been restricted to such frames as have the metal in actual contact with the skin. Aluminum has been used to a considerable extent for frames and is entirely satisfactory when separated from contact with the skin by padding. It can not be expected to meet the severe test for corrosion specified in rule 122. The more readily corrodible metals such as steel are prohibited in rules 22 and 23.

The manner by which goggles are retained before the eyes is not of primary importance. Comfort is important, as this largely determines whether or not the goggles will be worn willingly by the workers, and unless worn willingly there will be great difficulty in securing their general use, and hence the necessary protection against accidents and loss of eyesight.

SEC. 3. PROTECTORS FOR SCALING, GRINDING, ETC.

The goggles used for scaling and grinding are not subjected to severe blows. The lenses serve merely to keep small particles which are thrown off during the course of the work from entering the eye. Hence, no strength tests are necessary. It is the practice of some shops to use the same style of goggles for grinding and scaling as for chipping, especially where the two operations are carried on by the same men or in the same shop. This is a good practice because it avoids the danger involved in the interchange of protectors between workers using grinder's goggles and those using chippers' goggles. With two kinds of goggles some hazard is incurred; but as this may be overcome by proper supervision, it is not

considered necessary to require all grinders to wear the heavier goggles which meet the strength test prescribed for chippers' goggles in rule 21 (*b*).

Particles may be directed at an angle to the line of sight, and for this reason it is desirable to use lenses whose dimensions are at least equal to the minimum specified in rule 16. Side shields give slightly greater protection but a wide range of vision is desirable, and workmen who prefer to wear goggles without side shields should be allowed to do so.

SEC. 4. PROTECTORS FOR GROUP C.

The hazard from exposure to dust and wind is not great. The chief considerations are that goggles should be comfortable and light in weight. There is danger of particles directed from an angle entering the eye, hence it is not desirable to waive the minimum requirement for size of lenses.

SEC. 5. PROTECTORS FOR BABBITTING, ETC.

50. Styles.

The nature of the operation largely determines which style of protector should be used. If there is a probability of water being present, the danger of the molten metal exploding is great and hence protection to the face as well as the eyes is needed. It is desirable in this case to use the face mask. Protectors giving at least the degree of protection afforded by goggles should be used in all other cases to protect the eyes from splashing metal.

51. Specifications for Masks.

It is not desirable to restrict the kind of material to be used for face masks or the designs to definite types. A variety of material is available for making masks to accomplish the purpose.

52. Specifications for Goggle Frames.

Tests conducted by manufacturers and the Bureau of Standards demonstrate that the principal cause for failure of goggles is due to the heat of the molten metal and not to the impact of the explosion. The test consisted of dropping 5 g of molten lead from different heights on a number of lenses of different makes. It was found that in no case was the goggle frame injured, the damage being confined to cracking of the lens. With these facts in mind it is not necessary to specify a strength test for the frames. The design of the lens container should be such, however, that in case a lens cracks the fragments will be retained in position in the container. This prevents injury to the eye from flying glass.

53. Specifications for Lenses.

As stated above, a molten-metal drop test on a large number of lenses showed that the heat of the metal and not the impact is the important element in the test. It was found that for glass of a given make the thickness of the lens determines to some extent at least the resistance to cracking when molten metal is poured on the surface of the lens.

It was therefore concluded that protection will be afforded by a lens that will withstand a moderate blow of molten metal, and a lens container that will retain a cracked lens in position. The former is sufficiently assured by placing a minimum limit for the thickness of glass.

The need of unimpaired vision in the pouring of molten metal is apparent. This is the reason for specifying a minimum light transmission. Almost any lens made of so-called "colorless" glass will transmit 70 per cent of incident light. (See also the discussion under rule 21.)

SEC. 6. PROTECTORS FOR HANDLING ACIDS, ETC.

60. Styles.

The nature of the process for which protection is furnished when handling acids, caustics, fumes, and other corrosive or poisonous chemicals, determines to a great extent the type of protector to use. The operations are so varied that it is not deemed advisable to prescribe in detail the type of protector to be used. Judgment and experience must determine this.

61. Specifications for Goggles.

Goggles which do not fit the configuration of the face should not be used. In order to avoid splashing liquids coming in contact with the eyes it is desirable to use eyecups, which fit closely but which are provided with ventilating openings covered in such manner as to prevent the entrance of liquid into the eye. This will afford a means for escape of the vapor arising from perspiration which would otherwise condense on the lenses and obscure vision. Even the provision of ventilating openings will not obviate this altogether. In those cases where the presence of fumes would undesirably affect the tissues or would irritate the eyes or nostrils, ventilation should not be provided.

62. Specifications for Face Masks.

In processes where the operator is exposed to splashing or projection of large amounts of acids or caustics into his face, it is desirable to protect the entire face or even the entire head, as well as the eyes. A variety of material is available for making masks and hoods to accomplish the purpose, the design being such that there are no openings in the mask through which chemicals might pass.

63. Specifications for Hoods.

When working in gases which affect the mucous membrane or skin, hoods which cover the head and neck must be used.

Each process requires special attention. Therefore no detailed specification for the type of hood required can be made. Mitigation of the hazards in these processes is perhaps more in the province of the sanitary engineer and physician, since the health more than the safety of the operator is involved.

64. Specifications for Lenses.

Protectors for these processes are not likely to be subjected to severe mechanical shocks, and for this reason no strength tests are necessary. The material of which the lens is made should be given consideration before the protector is put in use. For example, the chemicals used in the frosting of glass (such as lamp bulbs) undesirably affect the glass, and hence in handling such substances other material must be used for the lens. Cellulose acetate is widely used. A property of this compound which makes its use desirable is its slow-burning quality. In this respect it is much more satisfactory than cellulose nitrate or celluloid.

SEC. 7. PROTECTORS FOR SAND BLASTING.

The hazard to which operators in sand-blasting operations are exposed is the inhalation of large quantities of dust over a considerable period of time. A hazard of a smaller degree is the abrasion of the skin by small flying particles. The problem may therefore be classed as one in industrial hygiene. The hazard may be largely mitigated by the use of properly designed apparatus. Obviously the best protection is derived through the use of apparatus which does not require the operator to be subjected to the flying particles nor to a great deal of dust. Sand-blast cabinets which are so arranged that the operator directs the sand-blast nozzle on the work through apertures in the wall of the cabinet have been successfully used on certain kinds of work. Where the worker is actually exposed, nothing less than a hood which completely covers the head is suitable.

All small particles and as much dust as possible must be excluded if effective protection is to be provided. The apparatus must be designed so that the operator is able to see his work. There are two designs of windows in general use. In one the hood is fitted with a glass which is provided with a suitable metal screen on the outer side which protects the glass from pitting. This combination effectually excludes the dust. In the other design the screen only is used, in which case a respirator to filter the air for breathing must be used. It is desirable to use goggles with this type of hood, inasmuch as the screen will not offer much resistance to the large flying particles.

The subject of ventilation of hoods has received consideration by a number of manufacturers. One large organization reports that the use of air under pressure caused operators physical discomfort because of colds in the head. Design of hoods to secure the proper distribution of air within and the proper air pressure to be used should receive further consideration.

SEC. 8. PROTECTORS FOR EXPOSURE TO GLARE.

The style of goggle to be used for protection against sunlight reflected from snow and similar sources of glare is of no particular moment. The reduction of the intensity of radiation entering the eye is the end to be accomplished. Since this can be done by the provision of a large lens, the use of side shields should be left to the discretion of the wearer, as should also the density and tint of the colored glass used in the lenses.

SEC. 9. PROTECTORS FOR OXY-ACETYLENE WELDING AND FURNACE WORK.

The style of protector to be used depends on the amount and nature of the work to be done. The more serious hazard of the process is the pathological effect on the eyes which is produced by the radiant energy from the light source. A

hazard of lesser degree is small flying masses of molten metal. Manufacturing limitations and hard usage limit the minimum thickness which can be used. This limit of thickness is high enough to offer protection against flying particles. The protectors need not, therefore, meet any strength tests. The design should be such that no unfiltered radiant energy is allowed to enter the eye. For this reason it is desirable for operators to wear goggles of style No. 3 (with eyecups), face masks, or helmets, whenever two or more operators work in close proximity.

The heat radiated from the work is so great that unless the parts of the protectors which touch the face are made of heat-insulating material the operator will experience considerable discomfort, which will tempt him to discard the protectors. The use of heat-insulating material is therefore required.

95. Specifications and Tests for Protective Glass.

A discussion of the optical tests for oxy-acetylene welder's glasses and the reasons therefor is given under rule 124.

The cobalt glass so commonly used by furnace men is not effective in providing protection from ultra-violet radiant energy. The judgment of many such men as to temperature and stage of reduction of a furnace charge has been developed while using such glass and may be dependent upon a continuation of its use. Moreover, inspection of the charge lasts but a few seconds at a time and consequently does not offer the same hazard as continued exposure to such sources of light. It is consequently suggested that the use of such cobalt glass be permitted by those trained to work with it and who are responsible for judging heats, but that its use be gradually eliminated by educating the new men to judge the condition of the charge by the use of glass which will afford more perfect protection.

As required by rule 11, electric resistance lap and butt welding where a relatively large amount of radiant energy is encountered are classified in the same group as oxy-acetylene welding. The reasons for this classification are given in the discussion of the tests for lenses, rule 124.

Two-part lenses, the lower half colored and the upper half clear, are sometimes used, particularly when the work is intermittent and the operator's attention is frequently distracted from his work. When close attention to the work is required for considerable periods of time, protectors using entire colored lenses are preferable.

In order to be assured that lenses which are satisfactory may be duplicated by the user of protectors, it is desirable that the lenses be marked in some manner so that they may be identified.

For reasons of economy it is desirable that lenses be provided with cover glasses which on becoming pitted can be thrown away and a new one inserted. The life of the more expensive protective lens is thus lengthened.

SEC. 10. PROTECTORS FOR ELECTRIC WELDING.

100. Styles.

As in the case of oxy-acetylene welding the hazard to be protected against is the intense radiant energy. In this case the ultra-violet radiation is so intense that serious burning of the skin as well as injury to the eyes may result from long exposure. It is therefore necessary to protect the face and head as well as the eye. The material from which the helmets or shields are made must be opaque to ultra-violet and visible radiation.

101. Specifications for Protection.

The forms of protector approved for electric-arc welders are the helmet and the shield. Helmets are generally of one

of two types, the type supported by the head and that supported by the shoulders. Either type is satisfactory if properly designed but support from the head appears to be more popular. Helmets and shields should be so shaped as to protect the entire face. Care should be taken that protection is afforded against the radiant energy from the arcs of other operators in the vicinity.

The design of helmets and shields is such that much better vision may be secured while the welding and cutting is being carried on by the use of a large single window than by the use of two separate lenses. This rule has been revised to permit the latter practice, however, by those who prefer it. An adequate range of vision is secured by the minimum dimensions for the windows specified in rule 102.

102. Windows.

A full discussion of the tests for arc welders' windows and the reasons therefor is given under rule 124. The use of cover glasses has been discussed under rule 95.

103. Protection for Other Workers.

The protection of other workers who may be exposed to the radiation from an electric arc is accomplished by segregating the electric arc welders in a room separate from the others or by surrounding them with a suitable opaque inclosure. In no case should arc welding or cutting be done, if other workers are or are liable to be in the vicinity, unless this protection is provided.

SEC. 11. OPERATING RULES.

110. Sterilization.

Goggles which have been previously used should be sterilized before being given to another employee. This will avoid spreading infectious diseases. It is desirable to furnish

each employee with a pair of goggles for his own use, but even in this case they should be sterilized periodically.

Several methods for sterilizing goggles are suggested. The use of an antiseptic gas is perhaps the preferable method, but is not always the most practical because of inadequate facilities, in which case other methods must be used. Boiling water will destroy nearly all germs, but its use should be restricted to those styles of protectors which will not undergo deterioration when boiling water is used. Examples of material which might deteriorate are certain types of composition lens and leather for side shields.

It is desirable that the work of sterilizing protectors be carried on only under the direction of competent and authorized persons. In many cases the sterilizing agent used may be poisonous, hence its use by uninformed persons should be restricted. The use of phenol is not recommended.

111. Supply and Fitting of Goggles.

Employees are required by rule 10 (*b*) to wear protectors when working in certain classes of operations or processes named in the rule. The mere fact that they are required to wear them will not always assure that this provision is carried out. It is incumbent on the employer to so organize his work that every employee is informed of the places within the works where he can go to obtain new protectors or have adjustments or replacements made. Constant supervision on the part of the foreman and superintendent will insure that full use of these facilities is made by the employees.

112. Replacement of Defective Protectors.

To charge the employer with the responsibility of repairing defective protectors as soon as such defect appears would be an unnecessary burden, as it would require exceedingly close inspection. A more equitable division of responsibility is to

require the employee to report broken protectors whereupon the employer should repair or replace them.

113. Inspection of Protectors.

While the responsibility of reporting broken protectors rests with the employee, the question as to what constitutes a broken protector depends on the judgment of the individual employee. Many protectors have been in use so long that the lenses have become pitted so as to interfere with vision, as in the case of oxy-acetylene cutting, or the frames have become bent out of shape. These conditions should be corrected by periodical inspections.

The provision of suitable cleaners should be given attention. Each employee need not necessarily be provided with a cloth, but a periodical inspection should be made to see that suitable cleaning material is available in convenient locations.

114. Cases.

Goggles are liable to be damaged if carried loose in the pocket or with tools. The provision of a case for the goggles avoids carrying them unprotected. Unless a case is provided they are likely to be left in lockers or tool chests. This is particularly true when they are not continually in use. The employee can be more easily induced to carry goggles with him if a case is provided. They are then at hand when they are needed.

115. Supply of Protectors or Repair Parts.

If employees are prohibited from wearing defective protectors and are required to report such defects to the employer and if the employer is charged with the responsibility of the replacement of protectors, it is obvious that an adequate supply of either the protectors or supply parts for them should be available.

SEC. 12. TESTS FOR FRAMES AND GLASS.

120. Scope of Tests.

It is not intended that frames and lenses which are subjected to test will be used in service. Samples must be selected for this purpose. For frames, product of a factory should be fairly uniform, and approval of a model may be considered sufficient by the administrative authority. Lenses are not so uniform in quality, and samples from every large shipment should be tested.

121. Tests for Frames of Goggles.

The severe usage and the mechanical shocks to which chippers' goggles are liable to be subjected make it necessary that some assurance be given that the strength of the various parts of the frame is adequate. The flat transverse, the edge transverse, and the joint tests are designed to give some evidence as to the probability of the goggle withstanding the demands of service, so that in the event of the goggle being subjected to a blow, safety will not be decreased. The use of a frame which is too light may result in it becoming out of shape, thus causing discomfort, which may result in discarding the goggle. Under these conditions, even if worn, it may fail to protect.

It is obvious that if a goggle is to be effective the lens container must at least be strong enough to withstand the tests to which the lenses are subjected. This is the reason for the insertion of the requirement as to strength of lens containers.

As stated above, the test of the joints of the bridge and lens container is designed to give some evidence of the probability of the goggle withstanding the demands of service. Poor methods used in the assembly of the parts of the goggle will be shown by the presence of jagged ends appearing at the joints after the goggle has been in service some time.

This service condition is simulated in the test, and if the failure appears it is sufficient evidence that the goggle would not stand up under the demands of service.

The test consists merely in bending the frames so that the lenses face each other and restoring the goggle to its original shape as nearly as possible. This test subjects the joints to a stress which in poorly constructed goggles will be great enough to cause the bridge to separate from the container. Figs. 1 and 2 show the method of holding the lenses during conduct of the test and the appearance of the frame after bending.

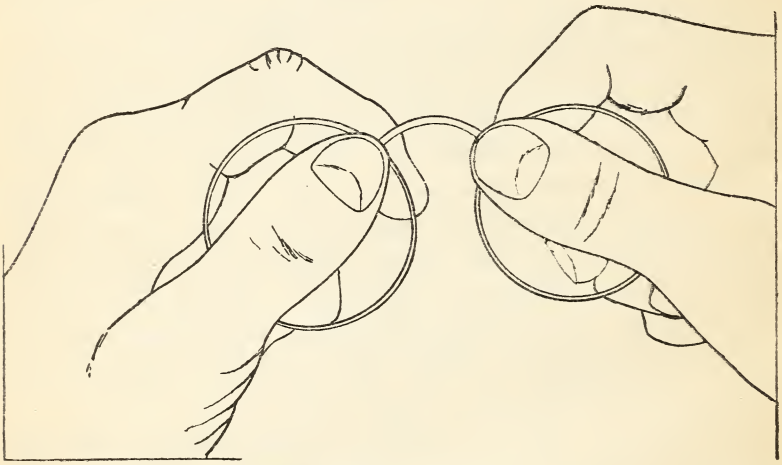

FIG. 1.—*Method of holding frames of goggles in making tests of joints*

122. Test for Corrosion.

The test for corrosion as outlined in this rule is designed to show the ability of metals to resist the corrosive action of such chemicals as sodium chloride and sulphur dioxide which are encountered in industrial operations. This is an effective test, but is not necessarily the only one which can be used. For the sake of uniformity it is desirable to use the test specified in order that test results from separate sources may be compared.

It has been found by observation that the use of a boiling solution allows the liquid to penetrate farther into the outer surface of the material, because of the action of the heat expanding the metal and opening up the pores, than is the case

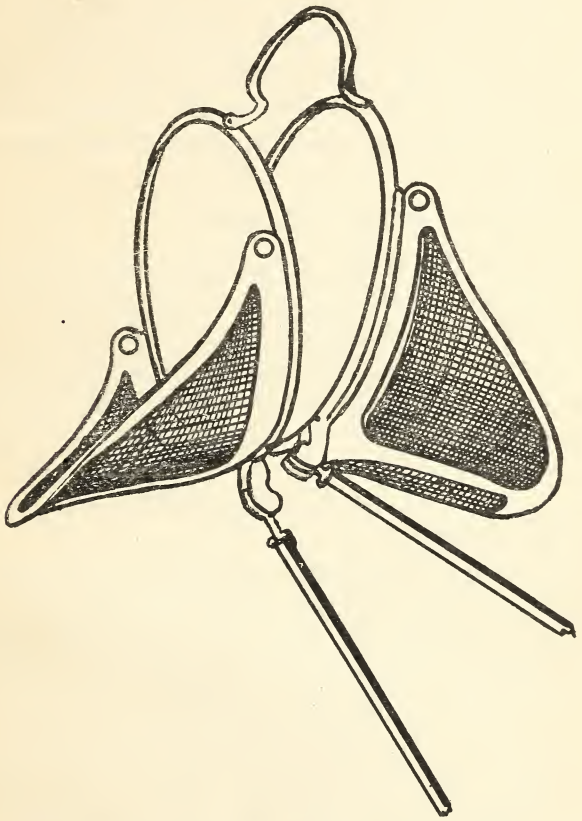

FIG. 2.—*Appearance of frame after bending*

if a cold solution is used. In order to retain the salt in the pores it is necessary to bring the metal to room temperature. This should be done by cooling in a solution of the same salt (sodium chloride) in order that contact between the solution

and the metal be not lost by the flaking off of the crystals which would form if the frames were allowed to dry in the open air.

The frames should not be wiped off after removal from the solution because this would remove not only the liquid but also all evidence of corrosion. A careful rinsing after the frames have dried a sufficiently long time to allow of chemical action between the salt and the metal, if any, will remove the adhering salt but will not remove the corroded particles or flakes. The presence of these particles shows that corrosion has taken place.

123. Mechanical Tests for Lenses.

Lenses for goggles used by chippers are liable to be subjected to severe blows. Hence in order to determine whether the quality of the lenses is such as to withstand the service, it is necessary to devise tests to which representative samples may be subjected. These tests are described in this rule and are based on the results of an investigation of samples of a number of manufacturers bought in the open market. They conform closely to tests which have been used by a number of large purchasers of goggles.

There are two types of lenses in general use for goggles used by chippers, namely, (1) lenses made of a single piece of glass, and (2) lenses constructed of two glass disks held together by a suitable binder. The protective qualities of the two types are based on entirely different principles. Lenses of the first type depend on the strength of the glass and upon the method of mounting. The lenses are made of glass of such quality and so mounted that a severe blow may be received without fracture. There is no protection, of course, from the extremely severe blows which would drive the glass out of the frame and into the eye. However, for such a case, the wearing of goggles neither mitigates nor increases the hazard.

In the case of the two-element lens, a severe blow is expected to crack the lens, but the construction is such that the

glass will adhere to the binder and the particles do not impinge on the eye. The construction of the lens container in both cases should be such that the lens will fail before the container is deformed.

Since the criterion upon which the protective quality is based in each case is the ability of the lens to withstand a blow without splinters of glass leaving the lens on the eye side, it is apparent that the test should include this as a basis for acceptance or rejection. In general, test (1) may be said to be a test for solid glass lenses and test (2) for laminated lenses, but compliance with test (2) on the part of one-piece lenses is satisfactory.

The manner of supporting the lens container or frame during test is important; and in order to obtain consistent results both in a plant where testing is conducted at regular intervals and by manufacturers of goggles, a uniform method should be adopted. The goggles should be mounted on the rubber test block so that only the rim of the container rests on the rubber washer. By this method of supporting the frame a test of the construction of the lens container as required in rule 121 (*c*) is obtained. In some cases it may be necessary to remove the side shields in order to mount the lens containers properly. In the case of the eyecup goggles the rubber washer and its support must be so prepared as to fit uniformly the contour of the eyecup and distribute the blow evenly over the whole surface.

124. Optical Tests for Lenses.

The pathologic effect of ultra-violet radiant energy upon the animal tissues has long been recognized, but it is only in recent years that detailed studies have identified the harmful rays and their specific action. The skin as well as the eye is affected by ultra-violet radiant energy, especially when the intensity is high. The action is similar to sunburn. In such processes as arc welding, protection to the skin as

well as the eyes is necessary. Excessive brightness must also be avoided. Still another possible cause of impairment of vision might arise through the absorption of an excessive amount of heat energy by tissues and humors of the eye, but there is no direct evidence that the eye is more subject to injury in this way than any other part of the body. The injurious effect of infra-red radiant energy on the eye has never been definitely proven. However, protection against this is so easy of accomplishment that it seems desirable to provide it.

In order to provide complete protection it is necessary to limit the radiant energy in the ultra-violet to a negligible quantity; the brightness of the source must be reduced to a degree that no discomfort will ensue if work is carried on continuously; the radiant energy in the infra-red should be reduced so that it will not be unnecessarily large.

In order to be assured that adequate protection is provided it becomes necessary to know the optical properties of the glass used for lenses and windows. This is done by subjecting the glass to definite tests which, however, require special apparatus, the manipulation of which should be attempted only by experts.

Before proceeding with a discussion of the detailed tests it appears desirable to give a discussion of the method of making the tests in order that their application and limitations will be understood.

Most sources of light emit mixed radiation. That is to say, light waves of a variety of wave lengths are present in radiant energy. This is true whether it comes from a body of molten metal, from a lamp filament or flame, or from the sun. The eye is unable to analyze such light and determine its components. In this respect the eye differs vastly from the ear, which can analyze a chord and perceive the individual elements or tones. The eye has no such power of analy-

sis and gets only an impression due to the combination of wave lengths or colors of light which may be present. Moreover, the eye is very limited in the range of its perception, most of the radiation from the usual sources containing a majority of waves or rays which are not visible to the eye, since they lie outside of the range in which the eye is sensitive to light.

Light can be analyzed in a number of ways, the most familiar being by its passage through a prism of glass. This separates the waves of different wave lengths into a spectrum in which the different wave lengths appear as different colors. The visible spectrum ranges from the red to the violet. The waves outside of this range are designated as the infra-red on the one hand and the ultra-violet on the other.

When the light of different wave lengths is mixed together, the eye sums up the effect of the visible portion. Measurements of the intensity of the visible are made by means of the photometer, in which this intensity is compared by the eye with the intensity of the light from a standard source. For the portion of the radiant energy which is not visible other means must be used. Since when light is absorbed its energy may be entirely converted into heat, one of the most simple methods of measuring radiant energy, whether visible or not visible, is by means of a thermopile, where the absorbed light produces heat and this heat in turn produces a measurable electric current. The thermopile can be used to measure the total energy, or, if the radiation is analyzed into a spectrum, the energy of each particular wave length can be measured independently.

No glass transmits all of the light which is incident upon it, but some is always absorbed and some is reflected from its surface. Ordinary clear glass transmits a high percentage of the visible, but does not transmit either the very long waves or the very short waves. When glass appears colored

it is due to the fact that it does not transmit all of the visible rays but some of them are stopped by it. The transmission of glass is usually expressed as a percentage which gives the ratio of the amount of light transmitted to the amount which is incident upon it. This transmission is sometimes expressed in terms of the entire visible spectrum, sometimes in terms of a particular wave length which must of course be stated, and sometimes in terms of the entire radiant energy. It is measured by letting the light from a definite source fall upon the thermopile mentioned above and then interposing the glass whose transmission is desired. The ratio of the two deflections obtained will give the transmission.

The measurement can be carried out with any portion of the radiant energy from the source that may be desired. Thus one may use the total or one may spread the light out into the spectrum by the use of the prism and let only a single wave length or color fall upon the thermopile. Full details of the methods of making such measurements will be found in Technologic Paper of the Bureau No. 119, entitled "The Ultra-Violet and Visible Transmission of Eye-Protective Glasses," and in Scientific Paper No. 325, entitled "Spectro-radiometric Investigation of the Transmission of Various Substances." Much of the information in the latter is also given in Technologic Paper No. 93, entitled "Glasses for Protecting Eyes from Injurious Radiation."

When the transmission for a particular wave length is measured it is almost immaterial what source of light is used, providing it can be kept constant during the measurement. Since the transmission for the total radiant energy is dependent upon the transmission for each particular wave length, and since the amount of energy which gets through will depend upon the amount of each particular wave length emitted by the source, it is evident that the result will depend upon the composition of the energy received from the source. It is

consequently necessary when considering total transmission to have a definite and reproducible source of radiant energy. The value of transmission measured will depend upon the spectral distribution of the energy from the source. Consequently a source which is especially strong in light of one color and weak in light of another color will not be suitable. An example of such a source is a mercury-vapor lamp. A source of suitable spectral distribution would be the sun or some artifical source having a somewhat similar distribution and sufficiently reproducible.

For the tests here specified a source of light which is sufficiently reproducible and which is easily obtainable has been stipulated. This source is an ordinary incandescent lamp operated under specified conditions. The spectral distribution of the light from such a source changes somewhat when its operating temperature is changed. But this change is a gradual one, and slight changes in the operating temperature of a filament are not important. In order to make the source sufficiently definite it has been specified that it shall be operated at such a voltage as to consume 0.8 watt per spherical candle, which corresponds to the commercial rating of the 200-watt lamp. This commercial rating may, of course, be changed from time to time, but such change is not likely to alter the conditions sufficiently to make it necessary for it to be taken into account in testing lenses for compliance with these specifications.

If it is found that a lamp is operating at a slightly different specific consumption (watts per candle) at its rated voltage, correction may be made by operating at a slightly different voltage. Within a small range the change in watts per spherical candle is proportional to the voltage and amounts to 0.013 for 1 volt. Accuracy of adjustment is not important, as values of transmission are only slightly altered by large changes in operating voltage.

It is well to point out that such an artificial source is preferable to sunlight for several reasons. In the first place it is more convenient for use in the laboratory and is independent of the weather. In the second place, sunlight is not so definite, as it varies with the condition of the atmosphere, and with the altitude of the sun in the sky. The latter varies not only from hour to hour during the day, but also with the season of the year. Indeed, sunlight is so variable that scientists have not been able to agree upon any specification for its use which would serve to give "sunlight" a definite value.

The specifications have been chosen so as to make the necessary tests as simple as possible. It has already been explained that the two principal purposes of optical specifications are to limit the visible and the ultra-violet light. We will consider first the ultra-violet.

The wave lengths 313, 365, and 405 millimicrons represent intense lines in the spectrum of light from a mercury-vapor lamp. This lamp is suitable for measurements of transmission at individual wave lengths, although as pointed out above, it is not suited for measurements of total transmission. This source is especially rich in ultra-violet light and is useful on that account for carrying out a test of transmission in the ultra-violet region.

The spectrum line 405 millimicrons is visible to the eye and consequently a measurement at this wave length can be carried out with the more usual optical apparatus. For the shorter wave lengths photographic methods must be resorted to or else the measurements carried out by means of some such instrument as the thermopile already referred to.

The specification has been written with the assumption that the quartz-tube mercury-vapor lamp will be used in tests as the source of light and that it is sufficient to make measurements at the three specified wave lengths representing lines

in the mercury spectrum. This would not be permissible if commercial glasses had narrow transmission bands occurring at points between those at which the measurments are made. Experience shows, however, that no difficulty may be anticipated on this score. Measurements of a large variety of glasses show that the ultra-violet transmission is of two main types. In one type in which many blue and purple glasses are included, the transmission increases rapidly to a maximum at 320 to 380 millimicrons, as the wave length is shortened below 405 millimicrons. In the other type, to which the deep orange and brown glasses belong, the transmission decreases rapidly with wave length. Any glass of average thickness (2 mm.) which would be used for eye protection is opaque to radiation of wave lengths less than about 290 millimicrons. Hence the question of testing protective properties of glasses against radiations of wave lengths less than 280 millimicrons need not be considered.

From the above it is evident that measurements at the wave lengths specified in the rule will be sufficient to insure that the intensity transmitted at any point in the ultra-violet region of the spectrum is too small to be injurious. For Groups G and H it is sufficient that this value be less than 1 per cent at lines 313 and 365. For Group I where more intense sources are concerned the transmission is restricted to 0.2 per cent at these wave lengths and to 1 per cent at 405 millimicrons.

It has not been attempted to limit the transmission of visible light to the definite amounts which will be proper in different processes and occupations, since the wearer of the goggles can decide very easily what is suitable for a particular purpose. No visible light which is comfortable to the observer will injure the eye. Consequently only rough and rather high limits have been set for the transmission of visible light.

To protect from glare the light must be cut down at least one-half. But still lower transmission will frequently be desirable.

For processes included in Group H, such as oxy-acetylene welding and electric-resistance welding, no specific limit to the visible has been set, but the total radiant energy has been limited to 50 per cent. This insures considerable reduction in the visible as well as in the infra-red. The processes included in this group will require among themselves quite different reduction in the intensity of the visible light. The reduction must be much greater in acetylene welding than in much furnace work and any figures which might be set as suitable for one would not be suitable for the other. The comfort of the wearer is a sufficient criterion for this purpose.

Electric-resistance welding differs very much in the conditions presented in different cases. Where the incandescent metal is almost entirely screened from the worker's eye by the apparatus or by the material itself, protection is optional with the worker. Where the intensely hot metal is exposed, the conditions are much the same as for furnace work and similar protection is prescribed. The intensity of light differs greatly in different cases and a general prescription for the transmission of visible light would not be satisfactory. This is left for determination in individual cases, and comfort to the worker's eye is a good criterion of the sufficiency of the protective glass in this respect.

For electric-arc welding a lower maximum for the total energy has been set, since the source of light in this work is much more intense. An upper limit has also been set for the visible light, although it may be questionable whether this has any great value. In practice a glass will usually be required which reduces the intensity considerably more than the limit set in the specification. In attaining this purpose it is not necessary that a single glass be used.

INDEX.

[References are to section numbers (where preceded by "Sec.") and to rule numbers and the discussion of the rules. For example, "13" refers both to Rule 13 (p. 12) and to the discussion of Rule 13, on page 35.]

	Rule No.
Accident statistics, eye injuries	Sec. 1
Acids, protectors for handling	11, 60–64
Adjustable bridge	13
Adjustable eyecup connection	92
Administrative authority, application of rules	10*c*, 120.
Air bubbles in cover glasses	95*c*, 192*d*
Air bubbles in lenses	16, 64
Air pressure for hoods	63, 71
Application of rules	10*b*
Arc welding, protection for other workmen	103
protectors for	11, 100–103, 124*d*
Artificial light preferable to sunlight for testing	124
Artificial ventilation for hoods	63, 71
Automobile driving	11, 40–41
Aviation not considered	10
Babbitting	11, 50–53
Ball for drop test, steel	123
Boiling water for sterilization	110
Brazing	11, 90–95
Bridges of goggles, specifications	22*g*
tests	121
types	13
Broken lenses, retained in position	52, 123
Cabinet for sand blasting	70
Calking	11, 20–24
Cases for goggles	114
Casting	11, 50–53
Caustics, protectors for handling	11, 60–64
Celluloid for lenses	64
Cellulose acetate for lenses	64
Chipping	11, 20–24
Classification, processes and operations	11
protectors	13
Cleaning of protectors	110
Clear glass, transmission of light	21, 53
Cobalt glass limited in use	95
Colored glass	80
Colorless glass, transmission of light	21, 53
Comfort of employee, determining factor	124
Compliance with rules	10*c*
Composition lenses	21
Corrective lenses	14
Corrosion test for goggles	122
Cover glasses for lenses	93*b*
specifications	95*c*, 102*d*
windows	101*a*
Cracked lenses retained in position	52, 123
Cutting, protectors for electric arc	11, 100–103, 124*d*
oxy-acetylene	11, 90–95, 124*c*
Defective vision, goggles for persons having	14
Definitions	12
Design of protectors	15
Dimensions, lenses	16, 53
windows	53, 64
Dipping in metal baths, protectors	11, 50–53
Discoloration of skin	22, 23
Disease spread prevented by sterilization	110
Drop test, lenses	123
lens containers	121*c*
nonrequirement for corrective lenses	14
Dust, protection from	11, 30–32, 40–41
Ear hooks, specifications	22*d*
Employees, protection in vicinity of electric arc	103
responsibility	112

Rule No.

Employer, responsibility 111, 112, 115
Examination of protectors 10
Exploding molten metal, protection against 50
Eyecups, specifications 23*a*, 61, 92

Face masks, definition (*see also* Protectors) 12
dimensions of windows 53
lens container 24
marking 93*a*
specifications 51, 62, 93
where used 20, 50, 60, 90
Fiber, use for masks 51, 62, 93*a*
Flaws in cover glasses 95*c*, 102*d*
Flaws in lenses 16, 64
Flexible goggles 13
Flying objects, protection against 11, 20–24, 30–32
Formaldehyde for sterilization 110
Formalin solution as sterilizer 110
Frames. *See* Goggle frames.
Frosting of glass 64
Fumes, protection 11, 60–64
Furnace work 11, 90–95, 124*c*

Galvanizing 11, 60–64
Gas, antiseptic, for sterilizing 110
welding, protectors 11, 90–95, 124*c*
Gases, protection against 11, 60–64
Glare, protection against 11, 80–81, 124*b*
Glass, general requirements 16
use of clear or colorless 21, 53
Goggle frames, marking 22*h*
mechanical tests 121
specifications 24, 32, 41*a*, 52, 81*a*
tests for corrosion 122
Goggles (*see also* Protectors), assorted sizes available 115
cases 114
classification 13
collapsible, for storage 22*c*
definition 12
marking 92
minimum dimensions of lenses 16
provided with corrective lenses 14
specifications 22, 23, 61, 91, 92
where used 20, 30, 40, 50, 60, 80, 90
worn over corrective lenses 14
Grinding 11, 30–32
Groups, processes covered 11

Rule No.

Guards, protection for other workmen 103
substitute for protectors 10

Head band for face masks 93*a*
Head band for goggles ..... 22*e*, *f*, 23*a*, 61*a*, 92
Head protection 11
Health involved with certain gases, not safety 63
Heat, cause of failure with molten metal 52
effect on composition lenses 21
Heat-insulating material for protectors ..... 91, 92, 101*a*, *b*
Helmets (*see also* Protectors), definition 12
lens containers 24
opaque to radiation 100
specifications 94, 101
where used 90, 100
windows for 102
Hygiene, problem in sand-blasting .. Sec. 7
Hoods (*see also* Protectors), definition 12
specifications 63, 71
where used 60, 70

Incandescent lamp, standard for testing 124*a*
Inclosures for arc welding 103
Industrial operations concerned by rules 10
Infra-red energy, protection against 124
Inspection of protectors 113
Insulating material for protectors 101

Japanning 11, 60–64
Joints of goggles, tests 121*d*

Leather for goggle bridges 13
Leather for side shields 22*c*
Lens containers, methods of connecting 13
specifications ..... 22*b*, *g*, 23*b*, 52, 93*b*
strength tests 121*c*
support for drop test 123
uniform dimensions 15
Lenses, composition of 21
corrective 14
cover glasses 93*b*, 95, 102
cracked, retained in position 52, 123

Rule No.

Lenses, marking 15, 21, 95*b*, 102*c*
mechanical tests 123
minimum dimensions 16
optical tests 124
replacement 15, 23*b*, 93*b*, 112
specifications 16, 21, 31, 41*b*, 53, 64, 95
two-part 95
Light, protection against reflected ... 11, 80–81, 124*b*
transmission 21*a*, 31, 41*b*, 53, 64, 124
Liquids, protectors for handling .. 11, 60–64
Locomotive driving and firing 11, 40–41

Marking of face masks 93*a*
goggles and goggle frames 22*h*, 92
lenses and windows ..... 15, 21, 95*b*, 102*c*.
Masks. *See* Face masks.
Mechanical tests for lenses 123
Mercury-vapor lamp 124
Metal screen as window 71
Molten metal, danger of exploding ... 50
failure of lenses due to heat 52
Mucous membrane affected by gas ... 63

Noninflammable material for eyecups. 61*a*
Nose piece. *See* Bridges.

Operating rules 110–115
Operations, classification 11
Optical specifications and tests 124
Oxy-acetylene welding 11, 90–95, 124*c*

Padded eyecup for goggles 61*b*
Pathological effect of radiant energy .. Sec. 9
Perforated metal for side shields 22*c*
Phenol not recommended as sterilizer 110
Photographic method for test purposes 124
Photometer, description and use 124
Physician, province of 63
Pivotally mounted helmet 101*a*
Prism, use 124
Pouring joints 11, 50–53
Processes, classification 11
Protectors, classification 13
cleaning 113
defective or broken, reporting 112
definition 12
design 15
fitting 111

Rule No.

Protectors—Continued.
furnished by employers 10
inspection 112, 113
one style for two processes ..... Sec. 3
repair parts available 115
replacement 112
requirements for glass 16
specifications and tests, general 10*c*
supplied by employer 111
use, when mandatory 10
use, when optional 10

Radiant energy, protection against ... 101
standard source for tests 124*a*
transmission 124
Replacement of defective protectors ... 112
Replacement of lenses and windows .. 15, 23*b*, 93*b*, 101*a*
Respirator used with hoods 71
Rigid-front goggles 13
Riveting 11, 20–24
Rubber, use of, for protectors 61*a*, 62
washer for drop test 123
Rules for employees, general 110–115

Salt test for corrosion 122
Sand-blast cabinet 70
Sandblasting 11, 70–71
Sanitary engineer, province of 63
Scaling 11, 30–32
Screen metal, for window 71
Scope of rules 10*a*
Scope of tests 120
Segregation of electric welders 103
Shall, definition 10*c*
Shields, definition 12
opaque to radiation 100
protection for other workmen 103
specifications 22*c*, 101*b*
Short wave lengths, not measurable by thermopile 124
Should, definition 10*c*
Shoulder-supported helmet 101*a*
Side shields, specifications 22*c*
use on goggles 13
Skin affected by gas 63
Sodium chloride, test for corrosion ... 122
Source of light for tests 124
Spectroscope, use 124

Rule No.

Spectrum, description 124
Splashing metal, protection against 11, 50–53
Statistics of eye injuries ..... Sec. 1
Steel ball for drop test 123
Steel-making protectors 11, 90–95, 124*c*
Sterilization, by competent persons .. 110
face masks 93*a*
goggle cases 114
goggle frames 22*a*
goggles 91, 92, 110
helmets 101*a*
phenol, not recommended 110
protectors 110
temples 22*d*
Stone-dressing, protectors 11, 30–32
Strength tests of lens containers 121*c*
Striæ in cover glasses 95*c*, 102*d*
Striæ in lenses and windows 16, 64
Sulphur dioxide, resistance to 122
Sunburn, effect of ultra-violet rays similar 124
Sunlight, suitability for testing purposes 124

Temperature, effect on composition lenses 21
Temples, specifications ..... 22*d*, *e*
Tests, goggle frames 121
joints of goggles 121*d*
lenses, mechanical 123
optical 124
number determined by authority .. 120
Thermopile, use 124
Thickness of lenses 53
Transmission of light 21*a*, 31, 41*b*, 53, 64. 124

Rule No.

Transverse test of goggle frames ..... 121*a*, *b*
Tungsten lamp, standard light 124*a*
Two-part lenses 95*a*

Ultra-violet radiation, cobalt glass not effective against 95
effect 100
measurement 124

Ventilation of protectors 22*c*, 23*a*, 61, 63, 71, 92
Visible light, transmission 124
Voltage, effect of variation on testing. 124
Vulcanized fiber, use for masks ... 51, 62, 93*a*
Vulcanized rubber, use for protectors. 62

Water, cause of molten metal exploding 50
Wave-length, limitations of tests 124
Waves in lenses 16, 64
Weight of helmets, maximum 101*a*
Welders, segregation of 103
Welding, electric 11, 40–41, 100–103, 124*d*
gas 11, 90–95, 124*c*
Wind, protection 11, 40–41
Windows (*see also* Lenses), distance from eyes 102*b*
marking 95*b*, 102*c*
metal screen, used as 71
minimum dimensions of .. 53, 64, 93*b*, 102*b*
preferable to two lenses 101
specifications 16, 102
tests ..... 102, 124*c*, *d*
Wire mesh for side shields 22*c*
Woodworking 11, 30–32
Woven wire, used for face masks 51